PROBLEMS AND PROSPECTS OF COTTON IN DIFFERENT ZONES OF INDIA

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Cotton cultivation needs to be sustainable, offering livelihood security to millions of marginal and small farmers; such an enterprise has to be knowledge-based and market–driven and needs to evolve continuously through innovations in frontier sciences to break yield and quality barriers for satisfying present and future national needs and attaining global competitiveness with larger spin–off benefits to India. Cotton is the most important commercial crop contributing nearly 75% of total raw material needs of textile industry in our country. Cotton and Textile exports account for good share of foreign Exchange earnings of India, crossing Rs.70,000 crores. India has achieved significant breakthrough in cotton yarn exports besides increasing its global market share in cotton textiles and apparels. About 60 million people of our country are involved directly or indirectly in cotton production, processing, textiles and related activities.

India is the only country where all four cultivated species of cotton are grown on commercial scale and covers 8.5-9.0 million hectares. Hybrid cotton cultivation in about 50 % of total cotton area, is a significant milestone achievement in Indian Cotton scenario. Qqualitative and quantitative transformation has taken place in cotton production in India. The production increased from a meager 2.79 million bales (170 kg lint/bale) in 1947-48 to a high of 17.6 million bales in 1996-97 and an all time record of 28.0 million bales during 2006-07 (AICCIP, 2007). During the pre-independence period, India produced short and medium staple cottons. Today, India produces cotton fibres with staple lengths ranging from 6 to 120^{s} counts, from non-spinnable coarse to medium, long, extra long and superfine cotton. Due to rapid growth in Indian economy and increasing demand for cotton due to cessation of Quota Regime, the requirement of cotton has been projected at 35.0 million bales by 2010.

In India, cotton is grown under diverse agro-climatic conditions. Area wise, India ranks first in global scenario (about 20% of the world cotton area) but with regards to production, it is ranked second, next to China. The world productivity of cotton is 572 kg/ha as compared to 440 kg/ha in India. While cotton area in India has remained static since 1995 at around 85-89 lakh hectares, production and productivity have shown significant uptrends during last ten years. ***However, there remains lot to be done in the productivity front and need-based area expansion to cater to emerging requirements.***

Cotton is grown in India in three distinct agro-climatic regions The cotton growing areas of the country fall within 8 - 32°N latitude and 70 - 80°E longitude characterized by elevation range of 0 - 950 metres, annual rainfall distribution of 250 - 1500 mm and widely varying soil conditions in terms of colour, texture and nutrient status.. In Northern region, cotton is grown under irrigation in alluvial soils, in

Central region predominantly in black soils or vertisols as rainfed crop. In Southern region, cotton is grown in vertisols and red soils.

NORTH ZONE

The zone comprises states of Punjab, Haryana, and Rajasthan. The cotton cultivation is beset with threat from cotton leaf curl virus (CLCuV) disease, bollworms and water logging stress. Efforts are underway for release of high yielding CLCuV disease resistant cultivars. A limited success has been achieved in the release of hybrids (Om Shankar, HHH 223 and LHH 144) and varieties (H 1117, H1226, RS 810 and RS 875). However, the production of seeds of the resistant cultivars needs to be augmented on a war footing. In these States, the yield potential of hirsutum and arboreum varieties indicates the superiority of arboreum cultivars. However, desi cotton (*G. arboreum*) area has been eroded over the years. The main reason is that the desi cotton varieties have by and large coarse and non-spinnable lint. Hence, there is always a price reduction compared to American cottons (*G. hirsutum).* Recently released intraspecific hybrids, besides Bt cotton hybrids offer scope for improvement in this zone.

In spite of the fact that cotton in North Zone is fully irrigated, the average yield levels stagnate around 400 to 500 kg lint / ha, whereas the potential is around 800 kg lint/ ha under ideal irrigation and management conditions. However, certain areas are prone to flooding and waterlogging (Muktsar, Hansi, Abohar, Mahendragarh districts) with yield limitations in high salinity areas like Abohar and Mahendragarh. Besides adverse sowing season (in April and May), North Zone witnesses a harsh climate with high temperature (40 - 45^{o}C), aridity with a limitation in canal water irrigation. In Rajasthan, there is 20% reduction in cotton area in the recent years due to shortage supply in irrigation water. Research in development of high yielding Desi hybrids with improvement in fibre quality needs to be intensified and the desi cotton area needs to be raised, besides general increase in area under cotton as compared to previous years. Development of biotic and abiotic stress tolerant genotypes, further research on fine-tuning IPM including Bt cotton hybrids, cost effective Integrated Nutrient Management techniques for varieties and Bt cotton hybrids and further impetus to profitable cotton-wheat / mustard rotation hold much promise for sustainable cotton production in North zone.

CENTRAL ZONE

Nearly 65% of cotton area is accounted by this zone and Maharashtra alone accounts for nearly 30% of the cotton area. Even though the irrigation source and potential are very much limited in Central Zone, ideal temperatures and ample sunshine during grand growth and maturity periods and the extended moderately cool, rain free dry weather prevailing during October to February are favourable for obtaining higher yields (1000 to 1500 kg lint per ha). Irrigated holdings in Jamnagar, Rajkot, Junagadh, Ahmedabad, Surat, Bharuch of Gujarat are having the highest yield potential for cotton in India, followed by the summer irrigated tracts of Western Maharashtra (Rahuri, Padegaon) and irrigated holdings in Jalgaon, Aurangabad, Nanded and irrigated tracts of Madhya Pradesh (Khargaon, Khandwa and Indore).

Maharashtra: The State is having largest cotton growing area in the country accounting for nearly one third of national cotton area (30 lakh hectares). Since there are vast tract of shallow soils with poor fertility and also the precarious and uneven distribution of rainfall over larger area, the cotton production is only around 6-10 q/ha, though there are certain econiches having higher productivity (20-30 q/ha) throughout the State. The recurrent droughts and early termination of monsoon rains during September in Marathwada region call for strong water harvest programmes and farm ponds. It is observed that there is a vast potential for water harvest in the undulating terrain of Maharashtra. The total rainfall in cotton growing districts of Maharashtra is from 700 to 1000 mm and it should not be difficult to augment rain water through Farm ponds and Mini reservoirs.

The irrigated cotton in Maharashtra is having high yield potential (30-40 q/ha) and one or two life saving irrigation will make all the difference in raising productivity. **Such efforts undertaken by CICR, Nagpur in the Research Farm revealed the success of water harvest programme in stepping up the cotton productivity**. For every ten hectare area of the land, there could be one-hectare area under farm pond for effective water harvest programme. Efficient crop management strategies, successful extension of INM and water harvest programme (developed by CICR, Nagpur) and "Ashta" model IPM approach hold the key for record production in Maharashtra.

Gujarat: In Gujarat, an area of about 24 lakh hectares is under cotton. *Herbaceum (Desi)* cotton is being grown with challenges to enhance the productivity from existing lower level of 200 kg/ha . This State frequently faces drought and of late heavy rainfall and resultant flooding. With 90% of hybrids of *G. hirsutum* group and a range of Bt cotton hybrids, Gujarat has emerged as the largest cotton producer of 100 lakh bales during 2006-07. Water harvesting and life saving irrigation through farm ponds and development of high yielding drought tolerant genotypes can further strengthen the situation. The Narmada Project, when completed may also increase irrigation potential; thereby Gujarat may maintain the lead as the largest cotton producing state.

Madhya Pradesh: The physiography of cotton growing area of Madhya Pradesh (Khargaon, Indore, and Khandwa) shows an undulating terrain with soil depth varying from 15 cm to 2 meters. Productivity is very good (25 to 30 q/ha) in the valley portions, while it is very poor (5 to 8 q/ha) in eroded shallow soils. There is tremendous production potential for irrigated cotton in Madhya Pradesh as in other Central Zone States. The monsoon rains coupled with protective irrigations and cultivation of hybrid cotton holds the key for higher sustainable production in Madhya Pradesh, that has witnessed 18 lakh bales during 2006-07. Moreover, steps are needed for developing efficient genotypes suitable to shallow soils.

SOUTH ZONE

In South zone States, tracts around Dharwad, Siruguppa and Raichur in Karnataka, tracts of Guntur, Adilabad, Warangal and Karimnagar of Andhra Pradesh, winter irrigated tracts of Coimbatore, Erode, Salem, Dindugul and Madurai of Tamil Nadu offer good scope for high yielding packages. South Zone states are also ideal

for cultivation of extra long staple varieties of cotton, but the quality is assured only under irrigated conditions.

Andhra Pradesh: The cotton area and production has shown improvement over the years since 1990. From over six lakh hectares, the cotton area has increased to ten lakh hectares and production rose from about 17 lakh bales to 33 - 35 lakh bales. The productivity has also reached around 500 kg lint per hectare. Cotton is grown extensively in Krishna, Guntur, Karimnagar, Kammam, Warangal, Adilabad, Mahaboobnagar, Prakasam and Nalgonda districts. Intraspecific hybrids are grown in the state. The area under hirsutum and arboreum are concentrated in Adilabad and Kurnool districts. Bt cotton hybrids like RCH 2 Bt, RCH 20 Bt, Bunny Bt, Mallika Bt and Tulasi Bt are popular and sizeable area. Of the total cotton area, around 25% is under irrigated situation.

Multiplicity of cotton hybrids, spurious seeds, extensive use of poor quality and adulterated insecticide chemicals and pesticide abuse are the major problems leading to reduced yields and resultant social problems in otherwise high yielding areas of Andhra Pradesh. Climate also plays havoc with heavy rains and extended wet spell during October and November, resulting in the outbreak of pests (*Helicoverpa* and *Spodoptera*) causing extensive damage to cotton production. The wet climate and continuous drizzling diluted or inactivated even the most potential pesticide chemicals. The other major drawback in Andhra Pradesh is heavy dose of imbalanced chemical fertilizer application and monocropping of cotton practiced by cotton farmers. Extensive use of pesticide chemicals right from the seedling stage disturb and annihilate the parasites and predator population, leaving cotton to serious pest damages, mainly the bollworms, aphids, jassids, thrips and whitefly. Hence, appropriate remedies like Insecticide Resistance management strategies, Integrated Pest Management, Integrated Nutrient Management besides scientific methods of weed control and water management have been perfected through All India Coordinated Cotton Improvement Project of ICAR, State Agricultural University centres at Guntur and Nandyal besides Central Institute for Cotton Research. These measures are being followed in Andhra Pradesh for a better productivity of cotton and sustainability of cotton cultivation by farmers. Moreover any incidence of newer pest / diseases or any abiotic stresses on cotton are continuously looked into by the scientists and developmental officials for immediate problem solving approaches for effective follow up by the farmers. Besides, ICAR sponsored Frontline Demonstrations under Technology Mission on Cotton are conducted in farmers' fields for demonstrating newly released cotton varieties/hybrids and Bt cotton hybrids, proper fertilizer usage, micronutrient need etc, wherein 15-20 % yield increase are reported.

Karnataka: The area and production in Karnataka showed a downtrend over the years. The cotton growing area has come down to 4 lakh hectares. The area reduction is due to competitive crops like maize and pulses. Interspecific cotton hybrid DCH 32 is superfine cotton fetching premium price. Hence, the farmers continue to cultivate this hybrid, even though the production potential is only about 15 q/ha compared to the high yield potential of other intra-hirsutum hybrids to a tune of 20-25 q/ha. In Karnataka, a vast tract of dry land and dry farming areas occur from Dharwad to

Raichur and in this belt the Desi cotton (*G. herbaceum*) is cultivated. Though production potential of this long duration *herbaceum* cotton is as low as 6-8 q/ha, but it accommodates Onion and Chillies as inter crops and hence the farmers would like to continue to cultivate this cotton. The performance of certain improved *herbaceum* genotypes in coastal areas of the State offer bright scope for profitable cotton cultivation in hitherto underutilized coastal areas. In the remaining areas, other cotton hybrids as DHH 11, NHH 44 and other private sector Bt hybrids are grown. In Karnataka also, majority of cotton growing area (about 70%) are under rainfed condition. Augmenting protective and life saving irrigation is the only remedy to raise the cotton production and productivity of the dry land cotton. There is also potential to extend cotton cultivation in the irrigated command areas of Ghata Prabha, Mala Prabha and Thungabadhra ayacuts, provided the farmers leave monocropping of cotton and go for desi varieties of arboreum or desi hybrids to sustain cotton production and to save the crop from severe pest damages. Enhancement in productivity of quality hybrid DCH 32 and desi cottons/long-linted arboreum besides augmenting water resources and adoption of novel intercropping, rotation cropping in rainfed and irrigated command areas will fetch better economic returns to farmers and ensure sustainable production.

Tamil Nadu: The cotton area remains almost static at 1.3 lakh hectares, while production and productivity show moderate improvement. Sugarcane and paddy monopolize the irrigated land and only in scarcely irrigated areas and rainfed conditions, cotton is cultivated. In the main season, cotton varieties **LRA 5166** and **MCU-5** dominate the cotton acreage, while **MCU-7** and **SVPR-2** are cultivated as summer cotton. Variety **Surabhi has gained momentum and Sumangala is becoming popular,** while recently released Bt hybrids like RCH 2 Bt, RCH 20 Bt, RCHB 708 Bt, MRC 6918 Bt, Bunny Bt, Mallika Bt are gaining ground. Cultivation of extra long staple super fine cotton "**Suvin**" is limited to about 1000 hectares and the area is declining further. Extension of cotton area additionally to about one lakh hectares is a felt need and is possible as summer cotton and cotton as irrigated intercrop in groundnut and pulses and thrust to desi hybrids in coastal areas need to be pursued to realize higher productivity and sustainable higher production in the State.

The possibilities regarding bringing additional area under ELS (extra long staple) cotton need to be explored in Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra and Madhya Pradesh, as the country urgently requires around 15 lakh bales of ELS cotton by 2010. With India accounting for 40% of global share in fine and super fine yarn, the production needs to be stepped up in a concerted way from present 3 lakh bales of ELS cotton to 15 lakh bales in few years from now.

Ensuring Higher Productivity through Irrigation Management

Experiments conducted under AICCIP in the Central and Southern Zones revealed that the cotton hybrids recorded as much as 30 to 50 per cent higher yields when cultivated under irrigated conditions. Irrigation as an input combined with integrated nutrient and pest management can trigger higher productivity in Central and South Zone. In rainfed areas of Central and South Zone states, water harvesting through nala beds and construction of tanks in natural depressions help in storing

water for use in the post-rainy season as protective irrigation. The practice of applying liquid fertilizers at optimum levels and in split doses along with irrigation water through "**drip**" system will be the most efficient system for integrated irrigation and nutrient management. As the irrigated area increased, the productivity levels went up, quality changed for the better and there was significant increase in cotton production, notably in Rajasthan, Gujarat, Andhra Pradesh and Karnataka. South zone states are also ideal for cultivation of extra long staple fine varieties of cotton such as Suvin, DCH 32, Varalaxmi, etc., but the quality (staple length, micronaire, fineness) is assured only under irrigated conditions.

Flood irrigation, an undesirable practice is extensively followed in North Zone. In the North zone states, the excess moisture and inundation of crop due to heavy monsoon rain during July and August hamper crop production prospects rather than moisture deficits. Of course, the canal opening and irrigation water release patterns and management of irrigation water in the actual field conditions in the Northern Zone are reported to have lot of drawbacks, which minimise the yield, thereby resulting in a wide gap between actual and potential cotton yields. In command areas, controlled irrigation practices have to be implemented for optimal irrigation and better crop production prospect. In rainfed areas of Central and South zone states, water harvesting through nala beds and construction of tanks in natural depressions help in storing water for use in the post rainy season as protective irrigation. The provision of diversion drains helps safe disposal of water which otherwise can erode the land. Irrigation through broad beds and beds and channels are the improved version of flood irrigation and are practiced in rest of the command areas and in areas with lift irrigation. In Southern states, where water is scarce, farmers adopt ridges and furrow system and the furrows are irrigated for optimal wetting, avoiding wastage of irrigation water.

Drip Irrigation & Fertigation

Drip irrigation is well suited for water scarce areas as the Central zone States and for advancing the cropping season from June-July to April-May. Drip irrigation combined with fertigation is seen to enhance the yield by 25% over control.

The reasons attributed for increases in yield are:

1. Proper air water balance maintained in soil and hence plants do not suffer from stress
2. Plant growth is faster, continuous and vigorous
3. Shortening of growing season and early maturity allows higher cropping intensity
4. Lesser weed and pest problems with greater retention of squares and bolls

The major limitation in the adoption of drip irrigation appears to be the frequent and unprecedented monsoon storms. Hence, drip irrigation will be found useful in summer cotton and pre-monsoon cropping. In areas of scarce water resources and excellent crop production prospects with hybrid cotton, drip irrigation system can be adopted. Economy in irrigation water use will aid in enhancing the irrigated cotton area, thereby leading to additional cotton production with better

quality. The practice of applying liquid fertilizers at optimum levels and in split doses along with irrigation water through "drip" system will be the most efficient system for integrated irrigation and nutrient management. The extensive adoption of this technique is advocated in high yielding situations under hybrid cotton cultivation in Central and South Zone.

Enhanced yields - Nutrient Management Strategies stressed

Nutrient requirement of crops are decided by the rooting behaviour and foraging ability of the crops and varieties in question, the native fertility and productive status of the soils, the potential yields as decided by the "Soil-agroclimate" of the given location, the targeted yields and nutrient management skills. As regards nutrient management in cotton, under assured rainfall conditions, 40-60 kg N/ha for *arboreums* and *herbaceums*, 60-90 Kg/ha, for hirsutum and barbadense and 100-120 Kg N/ha for hybrids are found adequate. Under irrigated conditions doses higher than 100 kg N/ha are found profitable. Seed and soil treatment with *Azospirillum* has been reported to save 20 kg N/ha in cotton in Tamil Nadu, while *Azotobacter* can save 20-30 kg N/ha. Response to phosphorous has been inconsistent and non significant due to low requirement of P by cotton and the greater foraging ability of cotton roots for P absorption from deeper layers. Considering the long term maintenance of soil fertility, K is to be applied at half to one-third of the doses of N. In majority of cotton growing areas, cotton nutrition is much imbalanced with excess nitrogen and low doses of phosphorus and potassium. Soil test crop response studies should form the basis for nutrient recommendation, besides the cropping systems, and targeted crop yields. In high yielding situations, deficiency of magnesium, zinc and boron are noticed and foliar sprays could easily correct such deficiencies. Foliar sprays with DAP alternated with Planofix during fruiting period (80-120 days of crop age) enhances the productivity by upto 20% by alleviating bud and boll shedding.

Integrated Pest Management Approaches for sustainability

To sustain crop production without degrading the resource base that support the crop productivity, agriculture must become economically viable and ecologically sustainable. It is not a question of eliminating fertilizers and pesticides from the agricultural production scenario. **The issue is how sufficient productivity can be achieved through Integrated Pest Management (IPM) and Integrated Nutrient Management (INM), Integrated Weed Management and Integrated Water Management using local resources aiming towards sustainability**. Newer insecticides having novel modes of action and are categorized as eco-friendly insecticides have been evaluated for effective cotton pest management. Chloronicotinyls (imidacloprid, acetamiprid, thiomethoxam) and insect growth regulator diafenthiuron are selectively more effective on the sucking pests and less toxic to beneficial insects as compared to all the conventional insecticides. Spinosad, indoxacarb, emamectin benzoate, novaluron and lufenuron ensure effective control of *H. armigera* while being less toxic to beneficial insects in the cotton ecosystem. Amongst other relatively new technologies, pest and disease resistant varieties, trap crops, intercrops, biopesticides, bioagents and spot application method of systemic pesticides have been contributing significantly to eco-sustainable pest management. Large scale field demonstrations of IPM technologies in farmer's fields in several

cotton growing regions across the country showed that the pesticides usage was reduced by 30-40%, cost of pesticide application reduced by 40-50% and farmers obtain 20-30% higher seed cotton yield as compared to control villages where farmers used only pesticides for the control of insect pests.

Transgenic Approach for Control of Cotton Pests:

Low productivity is attributable to several factors; important amongst these are the losses in yield due to heavy insect pest and disease damage to the bolls. The major reason for low production can be attributed to the damage caused to the plants by insect pests, notably those caused by *Helicoverpa armigera*, commonly referred as American Bollworm. **Nearly, Rs. 1500 crores worth pesticides were used in the country only to control the bollworm complex of cotton**. This cost is nearly 40% of total cost incurred by the country on the control of all pests in all crops. The use of transgenic cotton (Bt cotton) on commercial scale is on the increase in many countries of the world. The results of various trials conducted in India under the aegis of ICAR revealed:

- Good control of bollworm species in different growing areas;
- Significantly higher yield and boll retention when comparing Bt cotton and control or non-Bt cotton; Reduction in expenditure on use of insecticide application;
- Additional revenue (Rs. 2500 to Rs. 4000 per acre) in farm income using Bt cotton as compared to non-Bt cotton; No adverse effect on non-target insects or adjacent non–Bt cotton plantation.

The Need for Bt cotton

The genetic resistance, one of the important pest management strategy, is available in cotton gene pool against the sap sucking pests such as jassids, whitefly etc and using this several resistant / tolerant varieties and hybrids have been developed and released in India. However, such kind of known resistance is not available against the bollworms. Hence, an alternate strategy is explored to circumvent this problem by cloning and transferring the genes encoding the toxic crystal δ - endo toxin protein from the soil bacterium *Bacillus thuringiensis*. The Bt transgenic cotton (Bollgard of Monsanto) has thus been developed successfully in USA, which has the ability to control the bollworms at the early stages of crop growth (upto 90 days) effectively. The first commercial Bt cotton variety was released in USA by M/S. Monsanto (Bollgard), which contains Cry 1Ac gene of *Bacillus thuringiensis*. Bt cotton is commercially grown in several countries like China, Australia, Mexico, South Africa, Argentina, India, Indonesia etc. World wide the area under Bt cotton keeps increasing year by year. Overall, about 12% of the world cotton is now planted with Genetically Modified varieties/hybrids (GMO) and ICAC has estimated the rise to be 50 % in 5-7 years.

Prospects of Bt Cotton cultivation

Bt cotton cultivars exhibited excellent control of *Helicoverpa zea* and *Heliothis virescens* and reduced impact of insecticides to create eco-friendly environment without compromising on yield. Since the Bt gene is effective during the early phase of crop growth, the bolls produced in the bottom branches of the plant are retained fully. The lint obtained from the bottom 1/3rd part of the plant is reported to be of highest quality leading to the production of more quality fibres. Because of the retention of early formed bolls in the plant, the crop enters into senescence early and matures early compared to non-Bt counterparts. This ultimately helps in harvesting of seed cotton in two pickings.

The major emphasis was given to the control of bollworms in Bt hybrids as against their non-Bt counterparts by considering the number of times the Economic Threshold Level (ETL) crossed, total number of sprays given for the control of various insect pests under protected and unprotected conditions etc. In all these aspects, the released Bt cotton hybrids were found to be more efficient as compared to their non-Bt counterparts. As compared to insecticide control of bollworms, Bt cotton technology will not harm non-target beneficial insects, reduction in production cost, increased profit, reduced farming risk and improved economic outlook for cotton. Use of this technology is also helpful in improving wild life population, reduced run off insecticides, reduced air pollution and improved safety to farm workers and neighbourhood. Extensive cultivation of Bt cotton in many parts of the world may lead to imposition of selection pressure on target insect in continuous mode and will encourage the development of resistance in insect towards Bt. All the Bt cotton hybrids released in India so far, have the transgene Cry 1 Ac which is found to have pronounced effect only on *Helicoverpa armigera*. But it is not so effective against others like Pink, Spiny and Spotted bollworms. Further, few of the Bt hybrids are seen susceptible to sap sucking pests. Hence, field strategies and biotechnological perspectives are the need of the hour. Keeping in mind the development of resistance to Cry 1Ac protein in insects, notable progress has already been made to diversify the transgene and to pyramid/stack genes which are having different mode of action so that development of resistance is delayed. The genes available for exploitation include Bollgard II of Monsanto (Cry 1Ac + Cry 2Ab), VIP COT of Syngenta (VIP 3A) and Wide Strike of Dow Agro Sciences (Cry 1Ac + Cry 1F). The problem with regard to fibre quality of some Bt hybrids may be circumvented by involving a proper combination of parents to produce superior Bt cotton hybrids for both yield as well as fibre quality.

Sustainability of Production through Efficient Transfer of Technology

Cotton cultivation needs to switch from input-based to knowledge-based growth and in this paradigm shift, the dissemination of knowledge plays a vital role. Efforts to enhance the production and productivity of cotton remain incomplete with proper innovative methods of transfer of improved production technology. Proactive role in technology dissemination through FLDs, Farmers' field schools, Trainers' Trainings etc., assume great significance. As a national endeavour, attempts have been made through "Cotton Front Line Demonstration" for efficient transfer of

improved cotton production and protection technologies and popularisation of improved cotton varieties and hybrids including Bt cotton hybrids. During past three years, the AICCIP network participating centres conducted a total of 3050 demonstrations with budgetary support from the Ministry of Agriculture, Govt. of India. It is heartening to note that the demonstrations of high yielding varieties and hybrids suited for various agroclimatic conditions, Integrated Nutrient Management practices, IPM and Insecticide Resistance Management strategies , use of biofertilizers and biopesticides, efficient water management techniques like drip irrigation, use of compatible intercrops in various Front Line Demonstrations conducted through the cotton growing tracts of the country have helped the farmers to reduce pesticide input significantly and make cotton production more profitable (Table 1; AICCIP,2006). The regulation of fertiliser Nitrogen and ***diversification of cropping systems as*** bund crops (redgram and cowpea), barrier crops (maize, sorghum and bajra), and trap crops (bhendi, chrysanthemum, wild brinjal and castor) that favour predators and natural enemies of cotton pests have been demonstrated to the farmers; with the result that the technologies have found real adoption. As a result, **the reduction of pesticide usage to an extent of 30-40%** has been seen. The best feature of the FLD Programme is the **feedback for the Cotton Scientists from Cotton farmers** and the rapid spread of technology. The concept of whole village adoption programme is another area that is gaining special attention for attaining greater success.

Extension of cotton to non-traditional areas in rice fallows in South and East India, encouragement to grow more hybrids in North zone, establishing better linkage between Research & Extension officials, organising more FLDs of newer technologies including newly released Bt cotton hybrids, mass production and supply of quality biocontrol agents and remunerative price to the farmers are to be effectively followed for achieving more production with profitability to all concerned. Integrated cotton cultivation or Contract farming holds much promise in improving productivity, reducing cost of cultivation and increasing the net returns to the cotton farmers, besides ensuring steady and abundant supply of required raw material to the textile industry. Guaranteed price to the cotton farmers and efficient input supply system will bring in health and discipline to cotton system. The right policies, programmes and sincere efforts shall ensure Indian cotton an esteemed place in international scenario.

Table 1. Achievements In Zone Wise Cotton FLD Demonstrations

Technologies	Zone	Mean Seed Cotton Yield (kg/ha)		% Increase in yield
		Demonstration	Check	
Introduction of new varieties and hybrids	North Zone	1670	1403	19.03
	Central Zone	1106	933	18.54
	South Zone	1441	1208	19.29
	Average	**1406**	**1181**	**19.05**
Technologies	**Zone**	**Mean Seed Cotton Yield (kg/ha)**		**% Increase in yield**
		Demonstration	**Check**	
Agronomic Management	North Zone	1664	1409	18.10
	Central Zone	1214	966	25.67
	South Zone	1642	1388	18.30
	Average	**1507**	**1254**	**20.18**
Technologies	**Zone**	**Mean Seed Cotton Yield (kg/ha)**		**% increase in yield**
		Demonstration	**Check**	
IPM Practice	North Zone	1770	1553	13.97
	Central Zone	1535	1433	7.12
	South Zone	1637	1308	25.15
	Average	**1647**	**1431**	**15.09**